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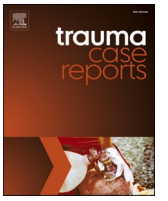

Case Report

Trans-scapular approach to intrathoracic rib plating of upper rib fractures: An innovative technique

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Introduction

Rib fractures remain a common injury pattern among trauma patients, and are associated with significant and well-documented morbidity and mortality [1,2]. Although still controversial, several studies within the last decade have suggested some improved outcomes in patients with rib fractures who undergo surgical stabilization of rib fractures (SSRF) [3,5]. This has led to significant interest in surgical intervention for rib fractures, although ideal patient selection continues to evolve. Despite controversy, surgical repair is currently recommended in the setting of flail chest [4]. However, some rib fracture patterns may be more or less amenable to surgical stabilization depending on location and planned approach. For example, rib fractures that are posterior may require significant mobilization of paraspinous musculature from an external approach, or disruption of the sympathetic chain, from an intrathoracic approach, both of which represent a significant and often prohibitive source of morbidity. Posterior fractures above the 7th rib may require larger incisions or some degree of scapula distraction to facilitate repair. Here we present a case of a patient with multiple left-sided rib fractures with flail chest, who underwent intrathoracic SSRF, including repair of rib fractures beneath the scapula, using an innovative trans-scapular approach.

Case presentation

A 66-year-old female presented as a transfer to our trauma center, after involvement in a motor vehicle collision in which she sustained a lumbar compression fracture, nasal bone fracture, and multiple left-sided segmental rib fractures to ribs 4 through 7 consistent with flail chest with associated mild hemothorax. On presentation, the patient was hemodynamically stable with normal oxygen saturation on room air. Exam elicited significant tenderness over the lumbar spine and left chest wall. According to our institutional protocol, a forced vital capacity was obtained to facilitate appropriate triage, with 900 ml elicited with maximal effort. She was admitted and started on a multi-modal pain regimen with scheduled Tylenol, Gabapentin, and as needed opioid, in addition to

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pulmonary hygiene, and re-evaluated the following day. No interventions were required by consulting services. On re-evaluation, the patient had significant pain, and was unable to take deep breaths or mobilize to sit up in bed. In the setting of flail chest, with poor pain control and impaired pulmonary mechanics, she was offered SSRF and consented to surgery. She was taken the following morning for surgery.

On the day of surgery, the patient was brought to the operating room and intubated with a double lumen endotracheal tube by anesthesia for single lung isolation, with bronchoscopy to confirm placement. The patient was placed in right lateral decubitus position on a bean bag, and prepped and draped in the standard fashion. We used both preoperative computed tomography scan with 3D reconstruction (Fig. 1), as well as bedside ultrasound to identify the fracture lines and plan our surgical incision. We obtained access to the pleural space in the anterolateral 8th interspace and inserted a 10-millimeter (mm), 30-degree camera. After confirming adequate lung isolation, a utility incision was made over the fracture line and dissected down to the chest wall in a muscle-sparing fashion and a mini thoracotomy was made for a working space for hardware insertion. We proceeded with cryoablation of intercostal nerves 3 thru 8 under direct visualization, approximately 4-centimeter (cm) anterior to the sympathetic chain, which has become largely standard practice at our institution to assist with pain control. For rib plating, the RibFix Advantage system (Zimmer Biomet) was used with 6 and 9 cm plates. For each fracture, a drill was used to drill two holes at least 1 cm on either side of the fracture line under thoracoscopic and direct visualization within the utility incision. A red rubber catheter was placed through each drill hole and retrieved and exteriorized through the mini thoracotomy. A wire was then fed through each red rubber catheter and pulled back through the drill holes

Fig. 1. Preoperative 3D reconstruction of CT of chest wall demonstrating left-sided segmental fractures to ribs 4 through 7.

and the red rubber catheter removed. A plate attached to the wires, was then inserted through the mini thoracotomy under direct visualization. The wires attached to the plate, were then used to pull the plate into position along the internal surface of the rib, to reduce the fracture. Washers and screws were used to secure the plate into position. Wires were then removed. This was repeated for each rib fracture. For ribs 4, 5, and 6, a trans-scapular approach was used. To accomplish this, we made a 10 mm incision over the scapula, and drilled a working hole through the scapula bone itself 6 mm in size (Fig. 2). A 5 mm short laparoscopic trocar was then inserted through the scapular hole and subscapularis down to the chest wall, and the scapula externally manipulated with the trocar in place to align the trocar and hole over the fractured rib. These ribs were then able to have similar drill holes placed 1 cm from the fracture line, through this working scapular hole, to accomplish similar placement of red rubber catheter and wires to insert plates into the chest for fixation of rib fractures directly beneath the scapula. This was repeated for ribs 4, 5, and 6. Once all plates were secured in place, the chest was irrigated and a chest tube placed. Incisions were then closed in layers. No immediate complications were noted. Postoperatively, a repeat forced vital capacity the following day demonstrated improvement to 1.6 l and the patient was downgraded to the floor (Fig. 3). Her chest tube showed no air leak, and was placed to water seal on post-operative day (POD) 2 and removed on POD 3. The patient continued to work with respiratory therapy, did not require significant supplemental oxygen, and demonstrated good pain control on oral pain medications with no major issues related to mobilization. She was discharged on POD 5 and seen in clinic approximately two weeks later where she reported some tolerable pain still present, but denied any issues related to pulmonary function. At a subsequent clinic visit, she reported improvement in pain, with only some issues related to sleeping positions and certain movements.

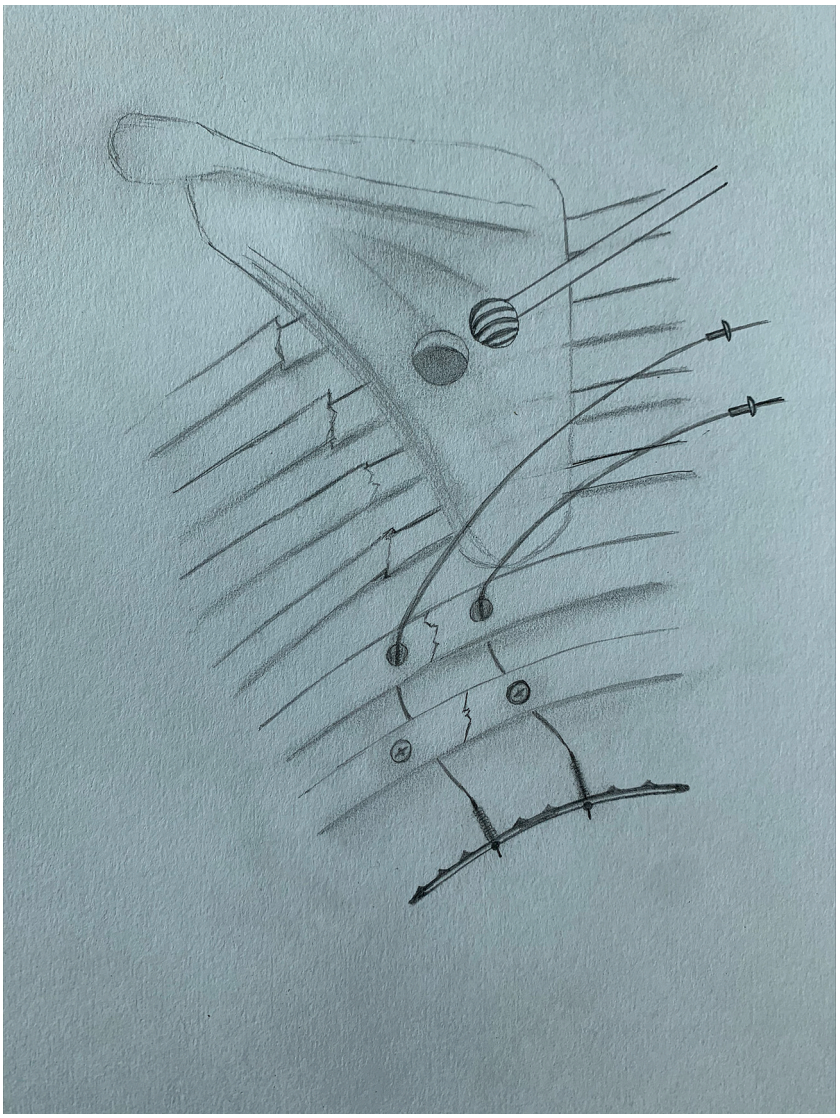

Fig. 2. Scapular working hole to facilitate access to ribs under the scapula for intra-thoracic repair.

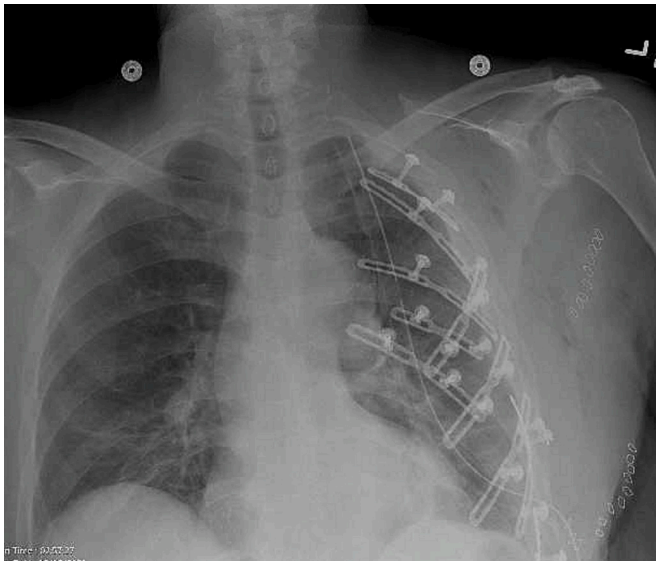

Fig. 3. Postoperative chest X-ray.

Discussion

Rib fractures continue to carry significant morbidity with high risk of chronic pain and pulmonary complications including respiratory failure and pneumonia, often associated with intubation, mechanical ventilation, and prolonged ICU and hospital length of stay [1]. Pain control and emphasis on pulmonary hygiene remain core tenets of management, to prevent pulmonary complications [6]. Rib plating, while still controversial, continues to evolve as new data informs better patient selection and indications for surgery. Current guidelines support surgical intervention for flail chest, and suggest some benefit for surgical intervention in select non-flail rib fracture patterns [3,4]. However, significant variability in surgical technique and fracture patterns remain, without any uniform standard approach. Efforts to surgically stabilize fractures to address pain and improve pulmonary mechanics are balanced against the morbidity of surgery itself. This has led to innovative approaches including thoracoscopic approaches with smaller muscle-sparing incisions to minimize surgical morbidity [7]. In this paper, we describe a technique that avoids a larger peri-scapular incision or significant scapular distraction to facilitate fixation of ribs with flail segment located directly beneath the scapula. We recognize that fractures in this area may not always need to be fixed if stability is otherwise adequately achieved. However, given our patient's smooth clinical recovery, we believe this may be a useful technique for difficult fracture patterns in this area. To our knowledge, this is the first description of this approach for fractures beneath the scapula.

Declaration of competing interest

The authors have no conflicts of interest to disclose. During the preparation of this work, no AI or AI-associated technologies were used in the writing process. The authors have reviewed and edited the content as needed and take full responsibility for the content of the publication.

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